NSW HEALTH

APPENDIX H

Combined Engineering Report

Liverpool Hospital Redevelopment

Concept Application and Environmental Assessment

August 2006

prepared by Sinclair Knight Merz Pty Ltd
for NSW Health

LIVERPOOL HOSPITAL STAGE 2

Part 3A Environmental Assessment submission to the Department of Planning

Appendix H -Combined Engineering Report

- Revision 01
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1. Building Engineering Services

1.1 INFRASTRUCTURAL ENGINEERING

1.1.1 EXISTING SITE INFRASTRUCTURE

1.1.1.1 Existing format

General

Studies have been made on the existing site by surveying the current services installations. Desk top reviews on existing record documents on various aspects of the infrastructure have allowed us to understand the configuration, capacity and spare capacity of the systems. This has also assisted us to form views on how the site can be handled to accommodate the redevelopment and the expansion of the accommodation on the Western Campus. This study forms the basis for the detail studies and design as to the concept plans on the Western Campus.

1.1.1.2 Electrical

Central Energy Services

This building is located on the East campus & contains:

11kV switchboards

11kV emergency generators

11kv/415volt transformers

415volt main switchboards for mechanical services plant

Incoming Supplies

The incoming 11kV cabling & high voltage switchgear consists of:

1. Utility supply No.1 (Liverpool Zone), feeds the main HV Switchboard No.1, has a potential capacity of 9MVA & from indications via Engineering, the current maximum demand is approximately 6 MVA.

2. Utility supply No.2 (Moorebank Zone), feeds into the main HV Switchboard No.1, has a potential capacity of 2MVA, but is used only as a back-up facility upon failure of item (1).

The HV switchgear is approaching the end of its serviceable life, the accessing of spare parts becoming increasingly more difficult, virtually unavailable; this situation would be exacerbated by the time that any redevelopment programme could be realised; but any decision regarding retention or otherwise will depend on the final design philosophy of Liverpool Hospital as a whole.

3. Utility supply No.3 (Liverpool Zone), runs underground & feeds directly to HV Switchboard No.8 in Sub-station No.6 (Clinical Services Building) and has a potential capacity of 9MVA; from indications via Engineering, the current maximum demand is approximately 5 MVA

The present maximum demand of Liverpool Hospital is around 11MVA.

The existing HV switchgear is approximately ten years old and in reasonable condition and believed to be SF6 type or similar. However, any decision regarding retention or otherwise of this equipment will depend on the final design philosophy and load considerations of Liverpool Hospital as a whole.

The control & operation of the numerous HV switches is a complex process utilising a key interlocking system, with around nineteen possible options. This complexity would have to be addressed and some simplification formulated.

Mechanical Services

Mechanical services (415volt) switchboard No.1 is contained in a separate switchroom & fed from Transformers 1, 2 & 3, which are in turn fed from HV Switchboards 2, 3 & 4. Mechanical Services Switchboard No.1 is close to the end of its economic life & SKM recommend replacement of this equipment under the final design and possible expansion of the CES infrastructure.

Mechanical services (415volt) switchboard No.2 is contained in the main plant area & fed from Transformers 4 & 5, which are in turn fed from HV Switchboards 2 & 4. Mechanical Services Switchboard No.2 is in reasonable condition & may be retained or extended under the final design.

Spare Capacity

Regardless of the potential capacity of the utility cabling referred to above, it has not been confirmed at this time, the actual spare capacity available from the Supply Authority. However, it is likely that the ultimate redevelopment of the Hospital will result in a larger electrical demand, therefore larger incoming supplies and a probable change in the electrical supply philosophy.

Site Distribution

The main HV switchboard (No.1) and HV Switchboards (Nos. 2, 3 & 4) are all located in a separate switchroom in the Central Energy Services Building, from which HV cabling is distributed via the underground services tunnel and partly underground to the various sub-stations situated on the east & west campuses.

Power Factor Correction

The power factor correction equipment cubicle is situated in the main HV Switchroom. This equipment consists of capacitor load banks switched in stages, operates at 11kV and connects into Panel No.7. When this equipment was installed, it was sized based on the electrical demand at that time with a limited degree of spare capacity. This provided a power factor very close to unity. It is very important to keep the power factor as close to unity as possible to be effective in reducing the undesirable "wattless" component from the supply, resulting in lower energy charges.

The electrical load has probably increased in various parts of the Hospital, now resulting in the possible undersize of the power factor correction equipment. This would result in the actual power factor being below unity to a greater degree than is desirable and that the system is not as efficient and/or cost effective as it used to be.

It is certain that under the new development a larger load would be realised resulting in the need for larger capacity PF equipment. The final design would address this situation to provide equipment suited to the final maximum demand.

Clinical Services Building (Sub-Station No.6)

This sub-station, situated at levels 5 & 6 in the Clinical Services building consists of 11kV Switchboard No.8 with key interlocking circuit breakers, which is supplied via a separate, 11kV cable from the Liverpool zone network.

This switchgear is approximately 10 years old & believed to be SF6 type.

Another 11kV feeder comes from the CES Building (Switchboard No.4), the controlling circuit breaker being normally open, & utilised as a back-up supply. A third 11kV cable is linked to an interlocking circuit breaker, normally open at Sub-Station No.4 (Alex Grimson).

This switchboard supplies (415volt) Transformers 14, 15 & 16, which in turn supplies LV Switchboard No.7.

Standby Power System

The Central Energy Services building houses 2 x 1500kVA; 11kV generators, manufactured by AVK, which were installed around 10 years ago and remain in good condition. Upon synchronisation, (with each other but not with the mains supply), this emergency standby supply is fed into the reticulation system at 11kV & load shedding takes place at the low voltage switchboards within the sub-stations. The present testing process of these generators is a tedious and convoluted process which may be addressed and improved upon as part of the overall redevelopment strategy; it may be possible to arrange a significant mechanical services' electrical load for testing in the future. These machines are compressed air start, but the control and monitoring of this may have to be improved.

Emergency Supplies

The Central Energy building houses 2 x 1500kVA; 11kV generators, which were installed around 10 years ago & remain in good condition. Upon synchronisation, this emergency supply is fed into the system at 11kV & load shedding takes place at the low voltage switchboards within the sub-stations.

However, sub-station No.6 is an exception to this rule, having its own 3 x 750kVA;11kV generators, which are in reasonable condition.

Sub-Station No.6 -This sub-station, situated at levels 5 & 6 in the Clinical Services building consists of an 11kV switching panel with key interlocking circuit breakers, which is supplied via a separate, 11kV cable from the Liverpool zone network. Another 11kV feeding comes from the CES Building (Switchboard No.4), the controlling circuit breaker being normally open, & utilised as a back-up supply. A third 11kV cable is linked to an interlocking circuit breaker, normally open at Sub-Station No.4 (Alex Grimson).

3 x 2,000kVA transformers, are supplied from Sub 6 HV switchboard, feeding into a low voltage main switchboard with load shedding facilities.

The emergency supply comes from 3 x 750kVA; 11kV generators, which are in good condition, feeding into the HV switchboard, with interlocking circuit breakers.

The generators are tested on a weekly basis through a separate transformer & a low voltage load bank.

1.1.1.3 Mechanical Systems

Site Cooling

Studies have been carried out the cooling provision for the site. 6 No. water cooled centrifugal chillers provide chilled water to the most of the existing Western Campus. These are located in the Central Energy Building (CEB). Three of the chillers are new and have been installed to accommodate the Clinical and Education Scheme 1 development undertaken 10 years ago. Two of the three original chillers were replaced since the original system was installed leaving one original Carrier chiller. This is in need of replacement. Our initial assessments indicate that the current chillers are at maximum capacity but do meet the present load of the site. This is around 9.6 MW of cooling capacity.

Chilled Water Reticulation

On leaving the CEB the CHW reticulates through a sub level tunnel under the railway into the existing campus. It carries on under the extremities of the site. Initial study indicates that the capacity of the reticulation could provide another 2MW of cooling to the site but this is not sufficient for the extent of the development. It does provide some flexibility for running systems on reduced capacity when the extension or relocation of the Central systems is considered. The pumping capacity will need to be upgraded to maximise the additional reticulation capacity.

Heat Rejection

6 No. cooling towers reject the heat from the chillers via a condense water system. The on site discussions with engineering indicates the towers are not quite meeting the loads of the system. The condition of the towers appears visually to be mixed.

Site Heating

A site reticulated MTHW system id employed which is provided with heat from 3 No 3.3MW heating boilers. This is distributed throughout the site through the sub level tunnel. As with the chilled water system the boilers are at capacity but the reticulation has around 2 to 2.5 MW of spare capacity. This will not be sufficient to supply the new development.

BMS

A number of BMS systems are utilised on the site but nothing centralised is adopted. Engineering have indicated that they consider one of the systems particularly suitable for their requirements and would be happy for it to be extended.

1.1.1.4 Hydraulics

Sewer

The Sydney water Sewer enters the site from Goulburn Street and crosses the sit with a 450-mm line entering the site from Forbes Street to the north. The sewer passes through the remainder of the west site passing below the rail corridor in a dedicated tunnel to the east site where the thermal Station is located.

After leaving the rail corridor the sewer passes through the east site utility area and leaves this part of the Liverpool hospital site at the eastern most boundary

Sydney Water advise that the 525 mm sewer that is running below 75% full.

The 450-mm sewer from Forbes Street is 100% full

From the analysis carried out on the current proposals for the site, the expectations are that the 25% remaining capacity of the existing 525 sewer would be sufficient to accept the expansion program of the Liverpool Hospital.

Storm water

Sydney Water drawings dated 2004 and Arial photograph with mains superimposed show a recently constructed 1800-mm diameter Liverpool sub main (WLS) running along Elizabeth street crossing below the rail line to enter the East campus. The eastern site has a frontage to the Georges River. .Rainwater disposal may involve On Site Detention dependent upon the final development and the increase in impervious catchment, however OSD is considered improbable. This is covered under the drainage assessment section of this report.

It is anticipated that the general handling of storm water from the site will not change the capacity currently experienced in that the area of the development does not change significantly. Generally the catchment at ground level is transferred to roof level

Mains Water Provision

Recent water bills for the site (period 11Jan/1 Feb 2006) indicate that a typical water consumption of 617.636 k/l/day is being used. The conventional design allowance for water consumption in a hospital of this nature is 1000 litres/bed/day.

Domestic cold water services to the Liverpool hospital site comprise a 250-mm diameter Sydney Water feed main which terminates at a cyclone mesh hydrant booster and meter compound opposite the new Cancer building in Goulburn Street from the 200-mm diameter Sydney Water meter a 225 mm mains domestic service crosses the road and enters the site.

The 225-mm main is considered adequate to supply the existing and new proposals.

Gas

The estimated gas loads for the proposed expansion heating and domestic load is a 100% increase on the current load. The average daily gas consumption as measured in February 2006 ranged from 100 GJ day to 120 GJ /day.

A 100 mm diameter high pressure natural gas supply and 150-mm (100kPa) meter and regulator currently supply the site and is located adjacent to the car parking area in the eastern site near the thermal station which is the major gas consumer, reticulation to the west site hospital buildings is via the services tunnel.

As the load to the hospital is likely to double over the duration of the development, it is considered probable that the gas service supply will increase.

Initial contact has been made with the Gas Supply Company and continuous liaison will be maintained throughout the detail design development to ensure the coordination of the upgraded supplies with the construction and anticipated future requirements.

1.1.1.5 Medical Gas

Central Oxygen

The main VIE plant is located adjacent to the Central Energy Building. A 35mm copper supply leaves the location and drops into the tunnel to supply the site. It has been indicated that venturi suction is achieved on parts of the site utilising the oxygen supply rather than the central MA system, which is an unusual situation and expensive alternative.

Medical Air

Is supplied from a centrally located bank of 3 No Compair compressors V100 DA 2383 l per minute (each unit). Their duty is sized so that they each provide 50% of the load of the site. The MA supply passes through the dryers within the CEB before reticulating through the tunnel to the various locations across the site.

Vacuum

It has been indicated that venturi suction is achieved on parts of the site utilising the oxygen supply rather than the central MA system, which is an unusual situation and expensive alternative. Further investigation has found that this is not the case and that a number of vacuum pumps and receiver plant are utilised throughout the site as originally suspected. The existing buildings using independent vacuum are

Clinical Building (sub level plantroom)

Pathology (level 3 Plant room)

Caroline Chisholm (sub level plant room)

B , D and South wings (and parts of Alex Grimson) which utilise a venturi suction facility driven by the Medical Air system.

Specialist gas and other gas provision.

Local manifolded and reticulated supplies exist in various areas of the site. These appear to include nitrous oxide among other more specialist gases for the Pathology building and such areas.

1.1.1.6 Fire.

General

Current configuration -Liverpool hospital is currently protected by

a) Fire detection system throughout all on site premises

b) Fire sprinkler system to the car park level of the Clinical building, and A-wing of building No 25.

c) Emergency evacuation and intercommunication system throughout all site premises

Some of the existing detection sub panels are connected via a network system back to a main fire indicator panel (MFIP) located in the fire control room situated within the main entrance area, while others are connected as an alarm only.

The evacuation system is a stand alone system, served from a local panel.

Fire fan control functions which can be used by the NSWFB are also located in the fire control room.

Potential for expansion

Fire Alarms and Electrical Systems. The existing MFIP is capable of accepting all future expansion on the network system. The MECP will require upgrading or duplicated to accept the existing and additional buildings. The Fire Fan control panel will have to be renewed to accept additional controls. It is envisaged that all existing fire alarm systems and that for the new expansion is to be connect to the micro fibre cabling which will be installed for the communication and BMS.

Fire Sprinkler System

All new buildings have been developed top ensure that they are not more than 25metres above the lowest accommodation level. This negates the requirement to upgrade the existing water supply serving the site for fire sprinklers.

A number of the existing fire panels due not comply with current regulations and will either be replaced or upgraded as the scheme develops.

Potential for expansion

Fire Alarms and Electrical Systems - The existing MFIP is capable of accepting all future expansion on the network system. The MECP will require upgrading or duplicated to accept the existing and additional buildings. The Fire Fan control panel will have to be renewed to accept additional controls

Site wide fire detection -It is envisaged that all existing fire alarm systems, including that for the new expansion, will be connect to the micro fibre cabling which will be installed for the communication and BMS

Fire Brigade

Discussions will ultimately be required with the local Fire department to ascertain their requirements for the sites. This will occur as the particulars of the development become more defined.

1.1.2 Site Development Options.

1.1.2.1 Architectural Options and impact on Infrastructure

The most obvious impact is the increase in load for Power, Heating, Cooling and Utility supplies. Assessments have been carried out to ascertain the loads for the services based on the building being retained and the square area being constructed. The planning has taken full account of the necessity to expand Central Energy and the infrastructural supplies that reticulate through the site.

The planning of the site also incorporates the necessity to introduce additional utility supplies and equipment to ensure that this particular phase of work and potential future developments can be incorporated with minimal impact on the working hospital.

1.1.2.2 Infrastructural Developments to Support Redevelopment

1.1.2.2.1 Electrical

Power

The main intent of this development is to retain as much as possible of the existing switchgear, transformers & cabling, with replacements & additions as required to meet the final Liverpool Hospital redevelopment. However it is confirmed that the utilities power supplies to the building will be upgraded.

An assessment of the likely maximum demand for the final development has been formulated based on the proposed area of the new development. An initial approach has been made to the Supply Authority to obtain comments and assess requirements for a likely distribution upgrade, viz. the incoming high voltage cables, capacity & quantity, together with their likely requirement for a dedicated zone sub-station which has been alluded to in the past but, as yet, unconfirmed.

It is anticipated that the Supply Authority would require a new zone sub-station which could be located adjacent to the existing CES Building, which would contain a series of 11kV ring main units to protect 11kV cabling to various local sub-stations within the Hospital development. The intent is that the Supply Authority would be responsible for the provision and future maintenance of the incoming services and distribution switchgear.

From this point the Hospital would be responsible for the provision and maintenance of all cabling, HV switchgear, transformers and low-voltage switchgear.

The Hospital main supply would be metered at this point together with a monitoring connection to the Hospital BMS network.

In maintaining a central services facility, the significant distances to be considered with reticulation, dictate that high voltage cabling is the only feasible method.

It may be possible to retain some of the existing high voltage cabling, which for the most part, runs through the services tunnel.

The existing HV cabling would be utilised as far as possible and diverted and/or supplemented to provide the new site distribution.

With the possible demolition of some of the buildings on the West Campus, existing cables may be retained, diverted and /or supplemented to provide the new reticulation.

A new cabling route could be provided via a bridged link or links across the railway to contain new distribution cabling to supplement the existing services tunnel, providing an alternate secure pathway.

In all new and refurbished areas, it is essential that cable routes, risers, plant spaces, switchrooms, sub-stations etc., be addressed at an the early planning stage Their relationship to patient areas, critical areas is important with regard to the servicing of individual areas, plus the need to avoid electromagnet interference.

Any rooms that require shielding against EMI & EMR. etc. should be fixed at the earliest stage.

All existing sub-mains cabling would be retained, as far as possible; however, in areas to be refurbished, some adjustments to sub-main distribution may have to be implemented.

<u>Remote buildings</u>

The power supplies to these buildings would be upgraded as required as they are unlikely to be impacted directly by the main site.

The over all load requirements are more difficult to ascertain than with the other disciplines but it is obvious that upgrade is required to the site by virtue of the size of the development.

Generator Back up

The two 1500kVA, 11kV generators in the CES building would be retained, along with the three 750kVA generators contained within Sub-station No.6. The latter is dependent upon the final essential services load of the Clinical Services building not exceeding the capacity of 2 x 750 kVA gensets running at 80% of total capacity. This would accommodate one of the gensets being unavailable due to failure or servicing at any given time.

It is anticipated that the new Zone A development would contain its own new generating plant, possibly with some form of cross-switching/interlocking to the other generating plant to provide some degree of safety and redundancy. This arrangement is more practical and manageable where high voltage cables are involved in negating the problems associated with 415 volt distribution at long distance and its inherent voltage drop limitations.

Co Generation provisions

The provision of co gen would tend to push the central provision of power. The provision of CO Gen does not negate the requirement for back generators.

Comms

A philosophy for the site wide comms requirements needs to be developed. SKM will be working closely with the Health Services ITD to ensure the developments at sites like RPA are incorporated into this development.

This philosophy has been extremely successful at RPA and is being employed at Westmead hospital. It must be recognised that the areas that are required for this type of philosophy are significant and always impact on accommodation.

The nature of the systems employed is covered by recommendations and guidelines that limit the distances to a local comms room to within 80 meters radius. The level of redundancy of this system is an intrinsic part of the clinical environment and this must also be recognised when allocating space to support the local networks.

1.1.2.2.2 Mechanical

Cooling and Heating

Initial indication suggests that the heating and cooling loads for the will increase by 10MW individually. To deal with this increase the existing Energy Centre will have to be expanded- retain the existing plant of suitable condition and expand the CEB to accommodate the additional plant.

The tunnel infrastructure serving the site will be retained. The pedestrian link provided to link the two campuses will be utilised to expand the infrastructure to the other side of the site. The focus is on how it this is achieved whilst having the least impact on the existing hospital.

Whilst other options have been considered in detail, the retention and expansion of the CEB is preferred for the following reasons

- It seems unlikely that the asset realisation oof the real estate will be sufficient to offset the cost of the relocation of the CEB plant.
- The noise impact on the building from heat rejection will be easily controlled in this development and can account for future development of the rest of the eastern campus.
- The impact on the helipads both existing and future is non existent.
- It removes the operation of the CEB from the operation of the hospital.

1.1.2.2.3 Hydraulics

Domestic Cold Water Services

It is the intention of the development to provide a reserve water supply to provide at least 24 hours normal demand, with the facility to conserve this supply longer by simplistic control. The necessity of this will be reviewed in future study under the detail design for the development.

The proposition of centralised system or individual free standing systems serving the larger and taller building masses, both central and individual building systems have significant advantages as they have capacity to include UV irradiation and micro mesh screen filtration.

Part of this philosophy is that existing storage systems should not be altered

Hot Water

The existing buildings are High Temperature Hot water supplied from the mechanical services system as described herein.

Each building contains domestic hot water which draw heat via a plate heat exchanger from the HTHW mains ,this system is considered advantageous, other than it is probable that anti legionella heat exchangers would be utilised in stead of stainless steel pressure vessels.

Warm water

Department of Health Guide-lines and the National plumbing Code AS3500 both require Warm water supplies at temperatures of about 40 degrees C in hospitals. This can be achieved by several methods but it is proposed that a central system be employed to take advantage of the maintenance advantanges this solution presents. Such a system will include Duty and Stand-by Thermostatic Control and Ultra Violet irradiation to ensure a Legionella kill and a variable speed drive pump to ensure minimal thermal loss from pipe work.

The limited use of TMV’s will only be employed where it is not practically possible to provide an extension to those areas too remote from a warm water reticulation system.

1.1.2.2.4 Medical Gas

Expansion of energy centre will be assessed and the level or expansion determined to ensure the correct solution is employed. It is likely that a Central System for Oxygen will be retained.

Decentralisation of the Medical air systems will be looked at critically to determine the retention of a central system. The expansion of the clinical facilities and the increase in the requirement for MA tends to suit a decentralised, building specific system but this needs more consideration. It is felt that the existing systems will be adequate to serve the development especially with the removal of venturi suction systems from the MA system.

Local specialised gases would be viewed as the better solution and is in keeping with the current philosophy adopted for the site

Vacuum systems are best suited to local decentralised systems specific to each building or area as required i.e. This could be a centralised option for each building but, for the larger buildings it may be better to split these to departmental type plant.

2. Environmental Sustainable Development

2.1.1 Introduction

Environmental Sustainable Development (ESD) means to use, conserve and enhance the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

Providing ESD services to deliver sustainable, cost effective and commercially viable buildings requires a holistic approach and incorporates the following considerations:

- passive architectural design features and practices;
- heating, cooling and ventilation and electrical/power engineering techniques;
- use of renewable energy such as wind generated power and solar collection;
- hydraulic/water engineering techniques;
- life cycle analysis and embodied energy; and
- operational issues such as:
  - public and personal safety;
  - facility management (maintainability);
  - waste minimisation;
  - equitable access;
  - social and community context;
  - local economic impacts; and
  - safe and healthy environments.

2.1.2 Existing Situation

The ESD review of Liverpool Hospital as part of the concept plan preparation has involved a range of activities and consultations with a number of agencies and energy supply authorities. A review was also conducted of the reports prepared by SKM for the Project

Definition Plan (PDP) relating to the existing and future provision of mechanical, electrical and hydraulic services together with the relevant sustainability related standards.

The current conditions in relation to ESD at Liverpool Hospital include:

- design and architecture with minimal consideration of passive design principles;
- lighting installations that do not benefit from daylight integration or low energy design;
- heating, cooling and ventilation that do not integrate passive design principles;
- high water consuming cooling towers used with no apparent attempt to use the waste heat to provide any hot water or heating requirements;
- poor insulation quality to heating pipes;
- one large chiller used R11 ozone depleting refrigerant gas; and
- reliance on fossil fuels for energy with no apparent use of renewable energy.

2.1.3 Key Considerations for the design of Liverpool Hospital Stage 2

The key considerations and industry benchmarks associated with achieving ESD in hospitals are outlined in following documents:

- NSW Health Engineering Services Guidelines “TS-11” (Draft 2003);
- Government Energy Management Policy (GEMP) NSW Health;
- Government Energy Reduction Targets”; May 2002;
- Government and Health Service;
- Section J of the Building Code of Australia; and
- Green Star - Health As Built developed by the Green Building Council of Australia (GBCA).

These documents will form the basis of the detailed ESD proposals for the Liverpool Hospital Stage 2 project which will be developed as part of the detailed design process. The ESD proposals will also seek to address, where practicable and economically viable, the shortcomings in the existing hospital noted above.

In addition, the recent developments of other major NSW hospitals, such as Westmead Hospital, will be considered to ascertain if any recommendations from the design and construction process used in those projects can be considered for this project and will extend to the strategies employed for day to day operation.

2.1.4 Key Opportunities

The key ESD opportunities for the Liverpool Hospital Stage 2 project relate to the mechanical, electrical and hydraulic systems together with architectural design that considers techniques such as:

- natural ventilation;
- solar collection;
- harvesting rainwater;
- shading control;
- the building envelope's performance is a major factor when considering the consumption of energy by HVAC plant including elements such as mixed mode optimization, through BMS and careful plant selection;
- energy efficient light fittings and schemes to supplement natural lighting techniques;
- detailed consideration will be given to the environmental performance of healthcare facilities as delivered at construction completion; and
- methods of heat energy recovery from systems and the building itself.

2.1.5 Project Considerations

The building form of the Liverpool Hospital Stage 2 project will be designed to consider:

- orientation to minimize solar gain, dimension relative to use and sighting and planning location to rail and public transport relative to control emissions from the use of private vehicles;
- construction and materials- relative to embodied energy and low maintenance materials, impact on deforestation etc;
- services plant selection and operation and provisions for cost effective maintenance and operation; and
- opportunities for the integration of passive lighting and ventilation systems.

2.1.6 Implementation

The ESD will be implemented and achieved as part of the project as follows:

- modelling;
- comparative analysis;
- feasibility analysis;
- cost benefit analysis;
- establishing appropriate targets and benchmarks;
- implementation; and
- monitoring.

Consideration will also be given to incorporating ESD benchmarks into the Key Performance Indicators for the Managing Contractor and design team for the project. This will reinforce the commitment to ESD.

3. Stormwater Drainage & Flooding Assessment

3.1.1 Assessment Overview

The objective of this assessment is to identify the issues and requirements for stormwater management for the proposed development of Liverpool Hospital including the issues and requirements in regard to floodplain management. At this stage this has been undertaken primarily as a desk top study referencing 2m contours, the layout of the existing and proposed hospital and Council design standards, plans and specifications. A site visit and a preliminary meeting with Council engineers has also been undertaken. Hydrologic or hydraulic modelling is yet to be undertaken.

3.1.2 Aspects of Drainage Design

There are a number of aspects to be considered for the design of drainage systems including, site drainage (pits, pipes and provision for overland flow), discharging water quality, floodplain management control measures, onsite detention, serviceability requirements for vehicles and pedestrians in the design event and larger storms, water sensitive urban design, rainwater harvesting and erosion and sediment control. Comment on these aspects related to the proposed upgrade to Liverpool Hospital are given in the following sections and draw on requirements of Liverpool Council's design standards, plans and specifications as listed below:

- Georges River Floodplain Risk Management Study & Plan prepared for the Georges River Floodplain Management Committee May 2004
- Draft On-Site Stormwater Detention Policy by Liverpool City Council July 2004
- Draft On-Site Stormwater Detention Technical Specification by Liverpool City Council January 2003
- Development Design Specification – D5 Stormwater Drainage Design by Liverpool City Council January 2003
- Development Design Specification – D7 Erosion Control & Stormwater Management by Liverpool City Council October 2003

We understand that the State Government will be the approving authority for the hospital development and that their requirements will be consistent with and made in consultation with Liverpool Council.

3.1.3 Overview of Existing Catchment

The existing state of the site is predominately impervious consisting of roadways, buildings and other paved areas. Two metre contours obtained for the area indicate that the upstream catchment starts within the Liverpool CBD and generally flows towards the Georges River. The Liverpool Hospital site drains from west to east and is influenced by the slightly elevated railway lines separating the site.

Discussions with Council and a site inspection have identified existing drainage networks in the surrounding streets and within the site. More specific details of the existing stormwater drainange system will be obtained for detailed design however it is apparent that the existing catchment is drained by piped drainage for minor events with flow along roads and through the hospital site in larger events.

Liverpool Council has recently undertaken a hydraulic study for the trunk stormwater drainage from Liverpool CBD to the Georges River. The study area includes the Liverpool Hospital site however limited drainage features within the site were modelled due to the macro nature of the study and lack of drainage information available to Council within the Hospital grounds. The study identifies two main drainage lines adjacent the hospital site and provides depths and velocities along these lines.

Council have advised that a third main drainage line is scheduled to be installed in stages over the next two years. The new drainage line will be located along Moore Street to alleviate some of the load on the existing two lines. This will increase the overall capacity of the Liverpool CBD network and in turn facilitate increased capture of stormwater runoff in events upto the design capacity (i.e. generally a 20 year ARI). Beyond this event, runoff will continue along overland flow paths similar to the existing state.

Council have also advised that the flood level for the Possible Maximum Flood (PMF) is 10.9m Australian Height Datum (AHD) and 8.8m AHD for a 100 year ARI event. Based on these figures the majority of the hospital site appears to be above the 100 year ARI flood level but a significant part, particularly on the eastern campus, appears to be below the PMF flood level. However, this will need to be confirmed with detailed ground survey.

It is noted that some hospital facilities are presently located in buildings built at the natural ground level which, in some parts, are located within the PMF extents. In the current proposal, these buildings will be replaced by new development with all treatment, assessment, consultation and accommodation areas provided above the PMF level.

3.1.4 Council design standards, plans and specifications

An overview of the relevant sections of these documents related to the upgrade of Liverpool Hospital is given below. This includes a summary of the main requirements and where possible suggests complying/mitigating measures.

3.1.4.1 Floodplain Management Plan

The hospital site is located on the Georges River floodplain, with the eastern campus extending to the river bank and the main western hospital campus extending some 750m upstream of the Georges River. The most current floodplain management plan for the Georges River is entitled *Georges River Floodplain Risk Management Study & Plan,* May 2004 (Bewsher Consulting Pty Ltd). This plan includes a draft DCP covering development requirements within flood affected areas.

The Floodplain Management Precincts presented in the Study indicates that some of the site may be within the 100 year extent and is classified as a medium flood risk and that approximately 50% of the site, predominantly the eastern campus and a significant part of the western campus adjacent to the railway line is within the PMF extent and classified as a low flood risk. Confirmation of the flood risk classifications for the site (i.e. medium, low or not affected) will be identified from detailed ground survey and further review of flood levels from the hydraulic model.

It is assumed that Liverpool Hospital is classed as critical use from a planning perspective due to its important community function and post disaster role. The *Georges River Floodplain Risk Management Study & Plan* identifies critical use as unsuitable development for low and medium flood risk areas. However, as the hospital is existing, Council have indicated that development is considered as Concessional Development and thereby subject to the requirements from the Draft DCP – Flood Risk Management. This document provides controls and measures for sensitive uses and facilities within low flood risk areas. Controls for concessional development include:

- Habitable floor levels to be no lower than the PMF (i.e. 10.9m AHD) for the site.
- Engineer's report required to certify that the development will not increase flood effects elsewhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels and velocities caused by alterations to the flood conveyance.
- The minimum surface level of open car parking spaces shall be as high as practical.

- Enclosed car parking, with a floor level below the 20 year flood or more than 0.8m below the 100 year flood, shall have adequate warning systems and signage.

Other factors to consider include access in and around the site, storage of chemicals and post disaster functions. Of primary concern to Council is the need to maintain adequate access in and around the Hospital during major flood events and due consideration given to the storage and handling of hazardous substances stored below the PMF level. These are matters to be addressed in the development of site specific strategies.

It is noted that parts of the proposed building footprints are within the PMF extent. While encroachment is minor in comparison to the overall PMF volume, it will require further investigations to ascertain the impact, if any, elsewhere in the flood plain. Whether the development will increase flood effects elsewhere is dependent on the sensitivity of the existing floodplain and will be verified by modelling the proposed changes in the overall floodplain model.

The proposed ground floor level for the new hospital development on the western campus is 12.1m AHD and the basement level is 7.9m AHD. On the basis that all treatment, assessment, consultation and accommodation functions within the PMF affected area will be at or above ground floor level, all such service areas will be above the PMF level.

Where it is not practicable to design floor levels (including basements) above the PMF level, additional measures to provide flood immunity should be considered and/or the subject areas restricted to compatible non-critical uses. Based on the current Hospital concept drawings, the basement area proposed at the south-eastern corner of the main western campus will be below the PMF level. Design and operational strategies will need to be developed to mitigate the potential flood risk impacts on the new basement including a detailed flood response strategy.

Subsequent stages of design for the site will be required to demonstrate that consideration has been given to the following safety and environmental issues:

- Emergency management for patients, staff and visitors in events greater than a 100 year ARI.
- Hospital to maintain post-disaster functions.
- Access to and from areas lower than PMF e.g. storerooms, carparks, and associated ramps/stairwells.
- Handling and storage of potentially hazardous materials / chemicals stored below the PMF level.

In regard to access and the hospital maintaining a post disaster function in the event of a major flood, it is noted that much of the western campus is not affected by the PMF. Road access via the existing road system through the Liverpool CBD to the hospital would continue to be available. The feasibility of providing additional alternative access in a PMF event via the proposed new north link road is yet to be assessed.

In addition, the following principles are to be adopted:

- No public consultations, assessments, procedures or accommodation should take place below 10.9m AHD, noting the current proposed ground floor level is 12.1m AHD. Basements below the PMF level should be restricted to non-critical uses unless adequate flood proofing or means for removal is provided. The later may be required for some storage zones and/or sensitive equipment installations;
- Access to and from the hospital is to be maintained in a PMF event;
- Hospital operational policies are to be implemented for adequate warning and means for evacuation of persons, vehicles, equipment and stores. Temporary alternative facilities are to be made available where flood immunity cannot be provided. It is noted that access to loading docks and storage areas on the western portion of the site are above the PMF level and could be made available for such situations.

3.1.4.2 On-Site Detention Policy

The proposed development has been identified as a floodplain area in the *Georges River Floodplain Risk Management Study & Plan*. Based on this classification and in accordance with Council's *Draft On-site Stormwater Detention Policy*, OSD is not required. This policy specifies that OSD is not required for sites:

- substantially inundated by flooding; or
- where discharge for a 100 year ARI event can be accommodated by the existing stormwater systems; or
- where the impervious area of the site is not increased.

Advice from Council's senior land development engineer also confirmed that OSD is not required for development at the hospital site. This advice was provided based on the close proximity of the hospital to the Georges River and the understanding that there would not be a significant increase in impervious area compared to existing conditions.

3.1.4.3 Stormwater Drainage Infrastructure

Design requirements for stormwater drainage infrastructure in the Liverpool CBD catchment are specified in Council's Development Design Specification D5 entitled Stormwater Drainage Design and are summarised in Table 1.

- **Table 1 Stormwater Drainage Design Criteria**

Design Component	Design Criteria
Design Recurrence for Piped System (Minor system)	1 in 20 year ARI
Maximum Gutter Flow Width for 5 year ARI	2.5 m
Major Storm Event Check	1 in 100 year ARI
Channels and Open Drains	1 in 5 year ARI
Bicycle Path Crossing Structures	1 in 2 year ARI
Gross Pollutant Trap (GPT)	Accordance with Council engineers instruction (*Clause D5.13.11*)
Minimum Freeboard for building under major storm event	0.5 m

It is envisaged that any onsite stormwater system will connect into Council's existing trunk stormwater lines and/or be discharged directly to the Georges River. Water quality devices, GPT's and outlet treatments such as energy dissipators and/or rock mattresses will likely be required. The onsite systems will use existing pits and pipes where possible. Redundant stormwater infrastructure should be removed where applicable.

Stormwater runoff for minor events will be handled by pit and pipe systems with larger flows conveyed through the site as overland flow along roadways and footways. Additional measures such as pumps may also be required as part of the relevant building design.

3.1.4.4 Water Sensitive Urban Design

Liverpool Council has advised that they have not adopted a standalone policy with regards to WSUD but rely on EPA reduction targets for stormwater pollution and other Council specifications.

Council's Development Design Specification D7 entitled *Erosion Control and Stormwater Management* specifies that treatment of the first flush from developed areas is required. This requires the removal of pollutants from captured stormwater for a sufficient length of time to allow the most heavily polluted early flows from the site to be treated. No further treatment would be required under this specification as there is no change in land use proposed.

It is envisaged that this requirement would be addressed by the installation of suitable water quality devices to treat the early flows at stormwater outlet points with larger flows allowed to bypass the treatment device.

Drainage outlets should incorporate erosion and sediment control throughout the construction period. Particular controls will also be required to prevent any hazardous materials kept onsite from entering the stormwater drainage systems. Where feasible, roof water collection and rainwater tanks should be considered for water reuse purposes and used to offset the Hospital's landscaping and/or toilet flushing requirements.

3.1.5 Subsequent Stage Design Requirements

The scope of work required for further design development includes:

- Compilation of all available drainage information for the site and adjacent areas from Council and the Hospital.
- Detailed survey of the site.
- Thorough site investigations to determine existing situation including all existing drainage structures.
- Carry out a Flood Impact Assessment including confirmation of the flood extent for the 100 year ARI and PMF events referencing Flood Planning levels from the *Floodplain Risk Management Study & Plan*.
- Ongoing consultation with Council and relevant State Government Departments.
- Carry out a Stormwater Management Plan for the site, which will include:
  - Hydrological Assessment – Determine catchment boundaries and design rainfall for input to the hydraulic model
  - Hydraulic Assessment – Use a suitable hydraulic analysis for the existing and proposed drainage networks within the Hospital. Where possible this will draw on information and findings from Council's recent hydraulic study of the Liverpool CBD. Assessment to include overland flowpaths for events up to the 100year ARI event and special consideration of tailwater levels.
  - WSUD requirements relating to stormwater management, water reuse and selection of water quality treatment devices. Consult with the Department of

Natural Resources to confirm any special requirements in relation to the riverine corridor.

- Soil and erosion control plan

- Review existing flood response, evacuation and disaster planning strategies and provide input to a new Flood Response and Evacuation Plan for the proposed development.

Based on our consultation with Council, site visit and documents sourced to date it is envisaged that the following drainage infrastructure will be required for the proposed development:

- Reinforced Concrete Pipes (RCP).
- Council's specified Inlet Pits, or other approved types.
- Water Quality devices approved by Council.

Outlet Treatment devices such as energy dissipaters and rock mattresses.